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Determinants of Customer Intention for Sustainable Tourism Packages in Thailand Using Rough Set-Fuzzy Theory

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Abstract

Economic growth is largely driven by tourism, and sustainable tourism practices are receiving more and more attention as a means of protecting cultural and environmental resources. This research fills a critical gap in the literature by combining fuzzy logic and RST in tourism research to model customer behavior under uncertainty. By utilizing a hybrid approach that incorporates Rough Set Theory (RST), Fuzzy Delphi Method (FDM), and Confirmatory Factor Analysis (CFA). The theoretical framework combines RST for managing uncertainty with FDM to refine expert consensus, facilitating robust variable selection in ambiguous conditions. During the qualitative phase, input from 21 experts in tourism, marketing, and academia was analyzed using the hybrid Rough Set–Fuzzy Delphi (RSFD) model to identify key variables. In the quantitative phase, a structured survey was administered to 850 participants, selected through simple random sampling and distributed through social media to validate the constructs through CFA. The results revealed seven determinants of Sustainable Purchase Intention (SPI): Positive Impacts (PIT), Perceived Service Quality (PSQ), Electronic Word-Of-Mouth (E-WOM), motivation, satisfaction, loyalty, and destination image. Among these, satisfaction emerged as the most influential factor, as demonstrated by a high factor loading (0.96) and R^2 value (0.93) in the second-order CFA, thus methodologically justifying its prominence. The proposed framework offers practical insights for tour operators and policymakers to enhance sustainability-driven marketing strategies and customer engagement within Thailand's domestic tourism sector.

Keywords: Sustainable tourism, Rough set-fuzzy Delphi, Rough set–fuzzy, Destination image, Satisfaction.

1 | Introduction

Thailand has embraced Community-Based Tourism (CBT) as a strategic pathway to promote sustainability in its tourism sector. By empowering local communities and integrating environmental stewardship into travel

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experiences, CBT enhances visitor engagement while preserving cultural and ecological assets. This national focus further supports the necessity of researching consumer intentions in sustainable travel scenarios. Thailand's economy depends heavily on the tourism sector, which generates millions of jobs and substantially contributes to the country's Gross Domestic Product (GDP) [1]. Thailand's cultural heritage, natural beauty, and vibrant urban life make it the most popular tourism destination in the world, drawing millions of foreign visitors each year [2]. This diverse tourism offering, which includes ecotourism, cultural heritage tours, and beach vacations, showcases the multifaceted experiences available to visitors [3].

However, the rapid growth of the tourism industry brings challenges such as socioeconomic inequality, cultural erosion, and environmental degradation. To address these limits, the sector must shift toward sustainable tourism practices that align with environmental protection and the well-being of local communities while gathering the rising demand for ethical and responsible travel experiences [4]. Although sustainable tourism is becoming more and more important, there is a dearth of research applying hybrid decision-making models like rough set and fuzzy Delphi to explore consumer intention under uncertainty, particularly in emerging markets like Thailand.

Thailand boasts a considerable number of officially registered tourism companies, with even more registered in the first half of this year. The country ranks highly in weekly online shopping activities, with a significant portion of internet users aged 16 to 62 actively participating in online shopping [5]. Recent years have seen remarkable growth in travel spending, with travelers increasingly completing transactions through online platforms across various travel categories. Due to this emerging market trend, Thai travel agencies have significant promotional opportunities for international packages [6].

Southeast Asia has shifted from conventional mass tourism to more sustainable models such as CBT, emphasizing local empowerment and cultural preservation [7]. This transition is particularly relevant in Thailand, given the government's promoting localized, ethical tourism experiences through community engagement. The large number of Thai internet users and online shoppers allows travel agencies to run effective domestic travel marketing campaigns, enhancing brand recognition and tourism demand [8].

Beyond market potential, Thailand presents a compelling academic case research due to its high digital penetration, widespread use of social media in tourism, and cultural dynamics influencing travel behavior. These unique characteristics make it a theoretically rich environment for examining how digitally mediated factors impact sustainable tourism decision-making under uncertainty. Given Thailand's strong potential for domestic travel promotion and the limited research on sustainable purchase influences, the researcher chose to conduct our research in Thailand. The research field necessitates investigating how Electronic Word-Of-Mouth (E-WOM) and brand equity influence domestic travel package purchases made through social media in Thailand, as previous research has analyzed the effects of E-WOM and brand equity on online purchasing behaviors in various contexts.

According to Streimikiene et al. [9], travel has already become an inseparable part of human lives. Neither global world problems nor the threat of terrorism can defeat a passion for traveling. The Fuzzy Delphi Method (FDM) can be used to screen the criteria indicators from the literature [10]. The entire fuzzy AHP is used for pairwise comparison of weights, as there are plenty of evaluation criteria in the literature [11]. Service operations have grown at an earlier pace than other industries in an era of constant technological advancement, and they have maintained this high growth rate, according to research [12]. According to the research by Li et al. [13], WOM has changed into EWOM with the rise of Web 2.0 and new media platforms. Online comments made by customers on a business or product are referred to as EWOM communication.

Few research like the fuzzy Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), or Rough Set-fuzzy Delphi (RSFD), integrate fuzzy logic or RST into the examination but fail to provide a widespread model that accounts for the dynamic and context-aware nature of consumer behavior in the tourism sector, especially in the context of sustainability. A hybrid computational intelligence model integrating multiple techniques, such as fuzzy logic RST, could offer a deeper

understanding of sustainable tourism purchase behavior, providing actionable insights for marketers and policymakers.

This research employs a comprehensive approach that combines Confirmatory Factor Analysis (CFA), fuzzy Delphi, and RST to answer these themes. This research advances knowledge of sustainable consumer behavior in Thailand in addition to a replicable framework for other emerging tourism markets facing similar challenges of uncertainty, digital transformation, and sustainable development. Traditional statistical models often fall short of capturing subjective nuances and uncertainty inherent in consumer behavior. The hybrid RSFD approach enables the integration of both ambiguous expert judgment and data-driven rule extraction, making it especially suitable for modeling sustainable travel intentions in digital environments.

1.1 | Research Contribution's

Identification of key factors for sustainable tourism: The research listed seven critical dimensions affecting Sustainable Purchase Intention (SPI) in Thailand's tourism sector: Positive impact, service quality, and destination image. It applied mixed methods, as well as qualitative and quantitative methods, and provided actionable insights for developing sustainable tourism products.

Emphasis on customer satisfaction: The research illustrates the key position of satisfaction in shaping the customer decision process, particularly in terms of risk during uncertainty. The findings substantiate the need to directly emphasize customer experience in relation to loyalty and sustainability for tourism. Additionally, the findings provide tour operators with valuable information in service design aimed at providing the customer with optimal satisfaction.

Practical implications for tourism practitioners: The research findings provide insights for Thai tour companies wanting to respond to the increased demand for sustainable travel. By understanding the impact of factors such as E-WOM and loyalty, businesses can better design and promote tourism packages for environmentally-conscious travelers. These advances assist sustainability efforts in Thailand's tourism industry.

1.2 | Research Organization

The research is organized into several sections: Section 2 reviews related works and literature on sustainable tourism in Thailand. Section 3 describes the methodology, differentiating between qualitative and quantitative research approaches. Section 4 presents the results, while Section 5 provides a detailed discussion of the findings. Finally, Section 6 concludes the research, highlighting its limitations and suggesting avenues for future research.

2 | Literature Review

The Fuzzy Rough Sets Theory (FRST) serves as an effective decision-making method that enables solutions in situations involving imprecision and uncertainty. Chacón-Gómez et al. [14] offer an in-depth analysis of decision-making frameworks utilizing FRST, particularly for complex datasets that traditional methods cannot efficiently handle. Zhang et al. [15] explore integrating fuzzy parallel relations and in-sequence granularity in FRST, highlighting its ability to manage multi-source coupled information systems. These computational models have shown the ability to combine different data types to produce unified findings, resulting in better decisions across various subject areas.

In the field of renewable energy, Huang et al. [16] demonstrate how RST can be applied to assess and promote sustainable energy practices. By creating decision rules, the research offers a practical approach to integrating RST in renewable energy management, helping to address modern energy challenges. Demiralp [17] also advances RST by proposing a transitive neighborhood-based approximation method, which enhances rough set approximation processes and expands the applicability of RST in various practical domains.

The research by Sureshchandar [18] aims to develop a validated model to measure quality 4.0 implementation in the Industry 4.0 context. A survey of the literature and advice from experts helped identify 12 important axes, which were evaluated using CFA. The results demonstrate the model's dependability and the ongoing importance of both new technologies and traditional quality. To explore the potential of metaverse tourism in promoting sustainable tourism, the research by [19]. It uses UNWTO reports, google trends data, and prior research on Virtual Reality (VR) and human-computer interaction. Findings suggest metaverse experiences can enhance tourism resources and support sustainability goals.

Novák [20] establishes a new integration of topology, alternative set theory, and fuzzy type theory for rough sets. The foundations of RST show the capability to expand broadly, as demonstrated by Novák's [20] work, with versatile applications across various mathematical domains. The incorporation of interdisciplinarity supports researchers in creating new analytical strategies that combine different theoretical constructs. Future research in fuzzy rough sets highlights the need to develop advanced decision-making tools due to their critical importance. The researchers emphasize how interdisciplinary collaboration helps create innovative methods that enhance the effective utilization of RST in diverse research fields.

To identify cost-effective strategies in tourism, this research provides a framework for ranking European countries based on the ability to attract low-cost tourists [21]. Data Envelopment Analysis (DEA) assessed 2019 performance by comparing tourism expenditures and visitor numbers. Spain, France, Croatia, Denmark, Poland, and Hungary emerged as the most efficient destinations using the cross-efficiency method. The objective is to offer insights for countries like Iran to adopt similar low-cost tourism models. The method ensures fair comparison across nations. Results support policy development for sustainable tourism growth. A key limitation is the exclusion of post-2019 tourism dynamics.

A performance expansion matrix was used to rank these factors. Results highlight tourists' desire for increased access to entertainment and leisure as the top satisfaction drivers. Additionally, broader institutional involvement emerged as a key quality factor. The research bridges tourism quality science and practice, though its findings are limited to the specific context of war tourism in Iran.

Tourism offers underdeveloped nations benefits beyond revenue, including cultural exchange and infrastructure growth [22]. This research analyzes Pakistan's tourism-economic growth link from 1995–2012 using time series data from the World Development Indicators (WDI). The ADF test checks for unit roots, and Johansen cointegration confirms a long-term relationship between tourism and GDP. A strong positive tourism coefficient shows tourism's vital role in economic expansion. Granger causality results indicate a unidirectional influence from tourism to GDP. Findings suggest a feedback loop where tourism drives growth. A limitation is the historical dataset, which can not reflect current dynamics.

With rapid changes in business processes, research explores how business intelligence competencies influence marketing performance in tourism companies, considering Customer Relationship Management (CRM) as a mediator [23]. Using a descriptive survey method, data was collected from 253 marketing professionals in Tehran through questionnaires.

Structural Equation Modeling (SEM) with SPSS 26 and smart PLS 3 confirmed that business intelligence significantly improves marketing performance, with CRM mediating this effect. Results suggest that leveraging business intelligence can create a sustainable competitive edge. The research highlights the strategic value of timely, high-quality data. A limitation lies in the non-probability sampling method used. Tourism is vital in global economics, requiring inclusive planning for sustainable growth [24].

This research investigates the underexplored perspectives of foreign residents on tourism development in Qingdao, China. A comprehensive questionnaire reveals diverse perceptions influenced by age, income, and ties to the tourism sector. Results show varying views on tourism's economic, socio-cultural, and environmental effects. The findings emphasize the need to include both local and foreign resident input in policy-making. This inclusive approach supports more sustainable tourism development. The research's focus on a single city is a limitation, which can affect generalizability.

The investigation explores the key coastal tourism hub. Recognizing the overlooked yet valuable perspective, a detailed questionnaire survey was conducted to assess advanced computational methods to analyze the influence of demographic factors like age, income, and tourism ties [25]. Results show varied perceptions shaped by these variables, underscoring the need for inclusive tourism planning. The research offers insights for policymakers to craft strategies that reflect diverse resident views. A limitation is its city-specific focus, which can limit broader applicability.

In Balıkesir Province, tourism enterprises, especially those leveraging natural resources, were assessed for environmental sustainability certifications and procedures in electronic media [26]. The sustainability certifications of 118 lodging establishments and the web exposure were subjected to content analysis. According to the findings, only nine establishments possessed an "environmentally friendly facility" certificate, and seven of them displayed it on the websites. Few possessed a "green key" certification. A limitation of the research is its focus solely on online platforms, potentially overlooking other methods of communication.

Through empirical methods, including questionnaire surveys and data analysis, it examines how perceived value influences tourist pricing preferences [27]. Findings reveal a strong customer inclination toward value-based pricing despite differing evaluations of tourism offerings. Such strategies significantly enhance satisfaction and better meet customer needs. The research underscores the strategic importance of aligning pricing with perceived value for tourism development. Its insights offer practical guidance for strengthening Hainan's tourism competitiveness.

As sustainability gains global importance, this research explores key factors influencing tourists' Green Travel Intentions (GTI) in Vietnam [28]. Using a structured survey of 600 participants, the research examines the roles of environmental attitudes (ATE), concerns (EC), knowledge (EK), Subjective Norms (SN), and Green Marketing (GM).

Results show that ATE and GM significantly affect GTI, with ATE also mediating the effects of EC, EK, and GM. Additionally, SN moderates the ATE–GTI relationship, reinforcing the role of social influence. The report provides helpful information that can assist players in the tourist industry in creating successful GM campaigns. The use of convenience sampling is a drawback. The investigation addresses the challenge of efficiently discovering overdue taxes and promoting taxation fairness in Taiwan amidst the rapid growth of vehicle data in the Tax Bureau over the past 30 years [29].

It suggests a hybrid approach for intelligently classifying Vehicle License Tax Payments (VLTP) that combines the Delphi method with a rough sets classifier. A real-world dataset was used to evaluate the model, and the findings showed that it was more accurate and had a smaller standard deviation than other approaches. Crucially, tax authorities can use the interpretable rules produced by the rough sets directly in knowledge-based systems for VLTP classification. The research provides workable ways to increase the effectiveness of tax collection.

Commercialization plays a crucial role in the success of businesses, particularly for knowledge-based products [30]. The research investigates the factors influencing the commercialization process and predicts the likelihood of success. Data was gathered from startups at the Kerman Science and Technology Park (KSTP), with experts evaluating the relative importance of success factors using network analysis.

The critical factors identified include appropriate technology lifespan, political barriers, and marketing techniques. RST was applied to analyze the commercialization information of 100 startups, resulting in 18 decision-making rules. The top three rules, validated for accuracy, offer practical guidance for decision-making in product commercialization.

Five key determinants were assessed using the quantum picture fuzzy rough sets, and sustainable industry alternatives were ranked using the MOORA technique [31]. The investigation introduces an improved method, addressing causal relationships between factors. Results show that green bonds for carbon-free

project financing are critical. The research emphasizes the need to develop green bonds and secure government support to boost investment in sustainable projects.

Ten criteria and six tractor options were evaluated using the Fuzzy-Rough (FR) methodology, which combines fuzzy logic with RST [32]. The FR SiWeC method identified maintenance as the most essential factor. Using the FR RAWEC method, the Solectrac e25 emerged as the best option. These results were confirmed through comparisons with other FR methods and sensitivity analysis. The research emphasizes the environmental benefits of electric tractors and improves the FR methodology with the Bonferroni mean operator for harmonizing expert ratings.

The research examines by Kou et al. [33], EWOM research using bibliometric analysis and a systematic review. The findings indicate a notable rise in EWOM papers, primarily from the US and Europe. Most researchers have employed mixed research designs in the four main areas, focusing on theory building. Future research directions and implications are also discussed.

The growing influence of EWOM has captured the attention of customers, businesses, and marketers alike [34]. Different topics emerge from the analysis for each area. EWOM and sales, Ewom quality and qualities, and EWOM's role in customer information are the main topics of discussion in business. The investigation recommends further research in areas such as B2B applications, recommender systems, and underutilized platforms.

There is a correlation between more severe deficits in major psychiatric diseases (PSY) and a Family History (FH) of psychiatric disorders [35]. Findings indicated that patients' prefrontal activity was lower than that of HC, with SCZ patients with FH exhibiting much more severe impairment. These results emphasize how prefrontal dysfunction severity in major mental diseases is influenced by genetic loading. One of the research limitations is its cross-sectional design, which ignores changes in cognitive activity over time.

CFA limits, especially when cross-loadings are disregarded, are examined when modeling multiple indicator measurement data [36]. Although CFA is a reliable technique, it frequently makes the erroneous assumption that items are pure indicators of the constructs it is meant to measure.

This can result in skewed factor correlations and regression estimations. According to the results, CFA is appropriate when item purity is certain, whereas UFA can be better when cross-loadings are anticipated. One drawback of UFA is that its greater adaptability could result in more intricate models that call for bigger sample numbers.

The research by Streimikiene et al. [9] explores the role of sustainable tourism in strengthening destination competitiveness by aligning environmental, economic, and social goals. Using a systematic literature review, it identifies key drivers such as technological innovation and community engagement while also addressing barriers like consumer behavior and implementation challenges.

Findings reveal that despite growing interest in sustainable practices, shifting tourist behavior remains difficult. The COVID-19 pandemic has introduced new obstacles to sustainability in tourism development. The research offers insights and future directions, acknowledging limitations due to evolving global conditions.

Rahmadian et al. [37] comprehensively review how big data supports sustainable tourism, focusing on decision-making and impact mitigation across environmental, social, and economic dimensions. The research investigates data sources, analytical approaches, intended purposes, and application contexts through a systematic literature review and the PRISMA method. Results highlight that while big data has influenced sustainable tourism practices, its full potential remains underutilized. Limitations stem from the evolving nature and availability of big data technologies.

The research by León-Gómez et al. [38] explores bibliometric techniques; it examines key authors, influential institutions, regional research outputs, keyword trends, citation patterns, and co-authorship networks. Findings reveal significant trends in publication impact, highlight emerging and established research groups,

and outline dominant themes in the field. The investigation offers a structured overview of the scientific landscape and serves as a foundation for future research planning. Limitations include reliance on a single database and potential exclusion.

Veilleux and Sarrasin [39] examined Thailand's shift towards "quality tourism," questioning whether such models advance sustainable tourism or merely exacerbate wealth inequality. This highlights a growing concern in Southeast Asia regarding the equitable distribution of tourism benefits. This gap seeks to be addressed by integrating intelligent decision-support models grounded in fuzzy and RST. Recent research underscores the need for advanced decision-making tools in the fuzzy rough set domain to address complex real-world challenges. The interdisciplinary nature of FRST, as discussed by various authors, highlights the potential for new collaborative approaches that expand its use in diverse fields, from renewable energy to healthcare and beyond.

Chang and Chang [40] verified a model was developed to investigate tourists' preferences using fuzzy set theory to analyze 201 evaluations from 248 data points across 10 tourism destination attributes. The analysis identified that the level of prices, living costs, and tourist safety were the most influential factors in satisfaction. The findings suggest that tourism destination management can prioritize these areas to maximize the effectiveness of limited resources and enhance competitiveness.

2.1 | Research Gap

One constraint of employing RST for establishing customer intention related to sustainable tourism packages is accurately the limited areas among typical customer preferences and unclear customer preferences. The basis of RST is working with data that could be lacking or unreasonably clear, which can influence the degree of reliability of the discovered firm-level (i.e., business or context) determinants.

Similarly, large, diverse datasets containing varying levels of customer data that could affect the conclusions' generalizability due to different demographic groupings in the data prove too large for RST to handle well [41]. Chacón-Gómez et al. [14] used the fuzzy rating scale technique to assess customer intention towards sustainable tourism packages and faced difficulty in capturing rapidly highly diverse customer preferences as trends and travel behaviors constantly change.

As fuzzy logic accommodates a range of diversions leading to fuzziness in identifying precise decision boundaries, consumer intent could be challenging to the ambiguous findings. Another limitation of FRST is the use of multi-sourced data, which inherently leads to variability, especially when gathering customer response data from different sources with different relative accuracy and completeness levels.

The RSFD approach, the use of a Delphi phase, can eliminate some of the limitations traditional RST has surrounding customer intention determination for sustainable tourism packages when using the RSFD model. In the RSFD process, experts' opinions are utilized during the Delphi phase, which narrows the boundaries customers prefer regarding dimensions.

Expert input during the Delphi phase aids in collecting and determining customer intention reasoning by further limiting customers' thoughts on data points deemed incomplete, ambiguous, or missing while also increasing the likelihood of more accurate firm-level determinant discovery.

RSFD is a better approach to using large datasets in a systematic process of iteration and first-hand expert feedback, which allows for subsequent iterations of more predictive rules and decision-making structures. Using a substantial number of experts to create conclusions ultimately increases the generalizability of the results across various demographic groupings and mitigates the challenge of working with disparate data sources.

Furthermore, the RSFD uses a combination of fuzzy logic and rough set approaches that clearly identify customer intentions and intentions surrounding ever-changing consumer behaviors or trends.

2.2 | Conceptual Framework

Seven key determinants influencing sustainable tourism purchase intention in Thailand were explored in this research: PIT, PSQ, E-WOM, motivation, satisfaction, loyalty, and destination image. These constructs were identified through expert consensus using Rough Set and FDMs.

Each determinant captures critical psychological, experiential, and social factors shaping consumer behavior. They form an integrated framework to model sustainable travel decision-making under uncertainty.

Hypothesis 1. SPI→ PIT.

The intention to purchase SPI is expected to result in PIT, such as economic, environmental, and social benefits for the destination. The research suggests that sustainable consumer choices contribute positively to the tourism industry.

Hypothesis 2. SPI→ PSQ.

Consumers with high SPI tend to have higher expectations of PSQ, particularly in the context of sustainable tourism. The research highlights how sustainability-conscious customers can demand superior service standards.

Hypothesis 3. SPI → E-WOM (EWM).

Customers with strong SPI are more likely to share their experiences via E-WOM. The research shows that sustainability-driven consumers actively promote sustainable tourism through online platforms.

Hypothesis 4. SPI → Motivation (MTV).

Underlying MTV, such as environmental concern, social responsibility, or personal values, likely influence SPI. The research indicates that customers with SPIs desire to contribute positively to the environment and society.

Hypothesis 5. SPI → Satisfaction (SAT).

SPI is expected to positively influence SAT, as customers are likely to be more satisfied when the travel experiences align with the values of sustainability. The research confirms that satisfaction is a significant determinant of SPI.

Hypothesis 6. SPI → Loyalty (LYT).

SPI is likely to foster LYT, where customers who make sustainable choices are likelier to remain loyal to brands or destinations that align with the values. The research shows how sustainability influences long-term consumer commitment to tourism businesses.

Hypothesis 7. SPI → Destination image (DIT).

SPI positively influences DIT, as sustainable tourism practices contribute to a destination's environmentally and socially responsible reputation. The research indicates that promoting sustainable options improves a destination's appeal to eco-conscious travelers.

2.3 | Positive Impacts

Tourism has various positive effects on promoting activities, including protecting traditional cultural practices and historic sites. Investing in cultural landmarks protects these landmarks through maintenance services and stimulates local artists and cultural guardians Hamdi et al. [42], attracting tourists seeking cultural encounters. Through tourism, the environment becomes better understood and more sustainable due to financial support for protected areas and the promotion of eco-friendly operations.

E-conscious tourist flow creates financial backing supporting natural reserve protection, environmental conservation projects, and biodiversity preservation [43]. Tourism generates essential social and economic

developments in countries while simultaneously aiding job placements, cultural exchange activities, and social interactions [44].

2.4 | Perceived Service Quality

When consumers express pleasure with the overall caliber or superiority of the services they receive, it is known as PSQ. Liao et al. [45] claim this is highly significant as it could influence travelers' intentions to return and recommend it to others. In the hotel industry, PSQ is a metric service providers can utilize to enhance the offers and satisfy travelers' expectations. In the context of technical services, PSQ sheds light on the function of technology and illustrates measurement methods [46]. Travelers' total experience can be improved by raising the PSQ of tourism enterprises, which can encourage return business and favorable referrals [47].

2.5 | Electronic Word of Mouth

Positive or negative statements defined by E-WOM made online by current, potential, or former customers about a product or service significantly impact travelers' decisions, perceptions, and overall behavior in the tourism industry [48].

2.6 | Motivation

Motivation in tourism is driven by internal and external factors that compel persons to travel and connect with various environmental stakeholders [49]. Tourists nowadays are increasingly interested in seeking unique and memorable experiences rather than traditional sightseeing. It is crucial to consider motivation in travelers' decision-making processes. Additionally, a concept encompasses push and pull factors, experience-seeking desires, emotional influences, and cultural engagement [50]. Understanding these factors is key to ensuring customer satisfaction and mutual happiness for both the traveler and the service provider.

2.7 | Satisfaction

Thus, tourism satisfaction is described as the level of satisfaction tourists achieve from the travel experience to their expectations. This is a noteworthy relationship as it significantly contributes to repeat visits, patrons' word of mouth, and overall visitor loyalty [51]. Some lines are set on the relationship between tourist satisfaction and future behavioral intention, such as revisit intention and recommendations, which shows that a higher level of satisfaction can bring higher loyalty and advocacy for destinations [23].

It is known that various determinants, such as the influence of expectations and experiences, cultural factors, and the relation to satisfaction and behavioral intention, determine tourist satisfaction. These dynamics can be understood to increase service quality and enhance the vacation experience for tourists [52].

2.8 | Loyalty

Tourism loyalty is defined as the dedication of travelers to return to a given destination or service provider following the satisfaction and favorable previous experiences. For tourism businesses, loyalty is essential as it encourages loyal customers to return and share positively [53]. In terms of satisfaction, high levels result in higher loyalty, with perceived value acting as a mediator [54]. Various aspects of loyalty in tourism include its determinants, the effectiveness of loyalty programs, and cultural influences on loyalty intentions [55].

2.9 | Destination Image

Potential tourists' opinions and impressions about a place tourists' want to visit are known as the destination image. A positive destination image can lead to more visitors, improved tourist loyalty, and better destination competitiveness [56]. The dimensions of the destination image are the components. Cognitive evaluations play a role, and emotional responses are critical in forming a positive destination image [57].

Various dimensions of destination image in tourism encompass its key components, tourist behavior, and the impact of cultural factors [58]. *Fig. 1* depicts the framework of the hypothesis variables.

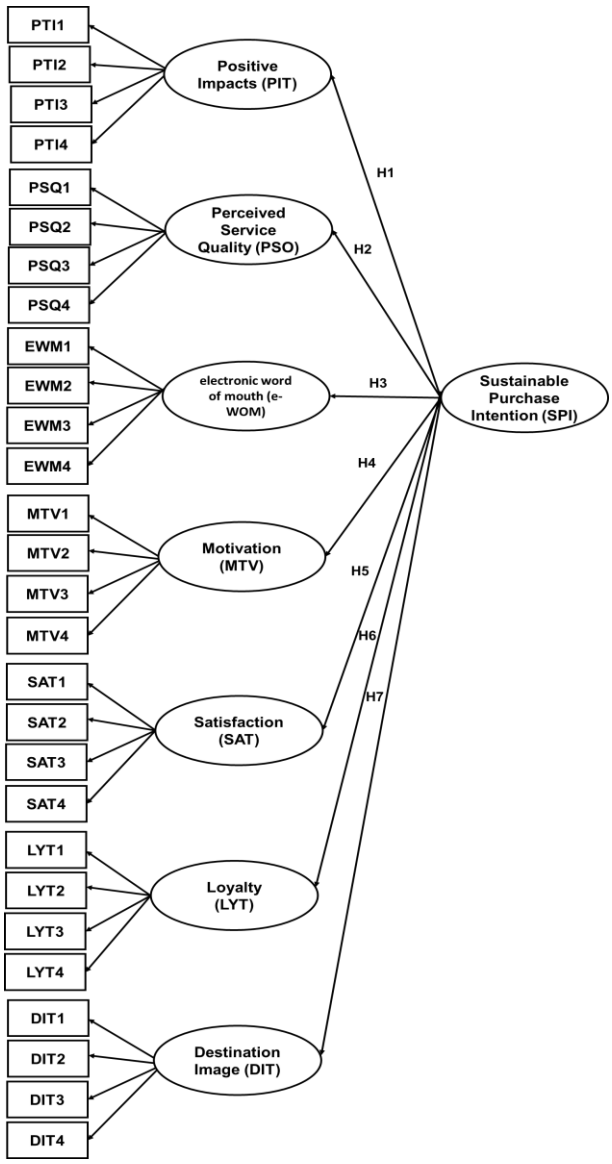

Fig. 1. The conceptual framework.

The conceptual framework was created to understand better the range of factors affecting intentions to purchase sustainable tourism packages in Thailand. The framework focuses on seven core variables: Positive impact, Perceived Service Quality (PSQ), E-WOM, motivation, satisfaction, loyalty, and destination image. These factors are interconnected and can have numerous influences on one another. Integrating these variables helps understand how digital consumer behavior and perceptions contribute to sustainable tourism consumer decision-making. This framework also identifies how intrinsically and extrinsically influenced purchase intentions interact.

3 | Methodology

The research used a comprehensive mixed methods approach to develop a new framework for customer intention for sustainable tourism package tourism in Thailand. The research was approved by the ethics review board of Rangsit University, and the approval number is No. RSUERB2024-086, the researcher, has been authorized to carry out the research. *Fig. 2* presents the flow of the entire process.

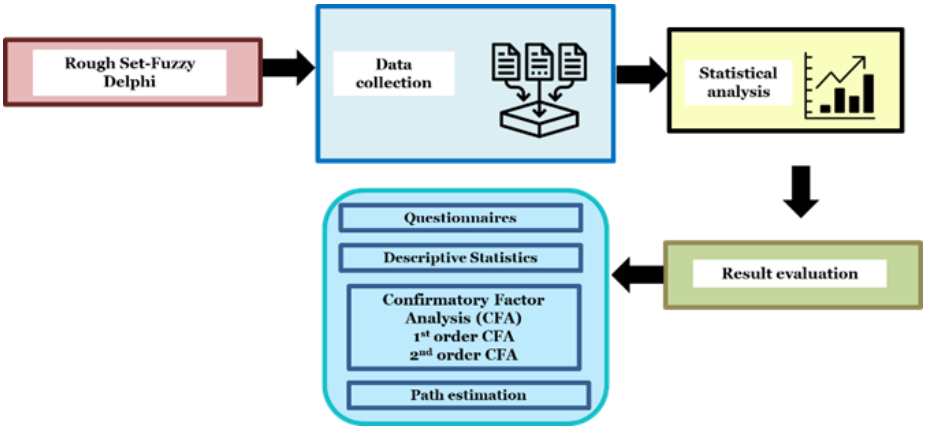

Fig. 2. Schematic diagram of methodology flow.

3.1 | Rough Set-Fuzzy Delphi

The RSFD combines the benefits of both the RST and the FDM in consideration of any uncertainty or subjectivity of expert-based decision-making. In this regard, RST does not consider pre-information but draws important attributes and patterns from data, which is very effective in the knowledge discovery process. On the other hand, the FDM uses fuzzy logic in aggregating opinions from experts, handling many ambiguities and variations in subjective judgment. An efficient technique is this for improving accuracy in selecting variables and ultimately reaching consensus at times of uncertainty. RSFD captures these complexities at decision-making levels.

3.1.1 | Rough set theory and fuzzy logic integration for sustainable tourism

In the context of sustainable tourism and customer purchase intentions, incorporating RST with fuzzy logic enables a robust analysis of uncertain decision-making environments [59]. RST traditionally deals with elusiveness and indiscernibility in data, while fuzzy logic allocates the handling of degrees of truth moderately rather than just binary decisions. This combination can address the difficulty and improbability in human decision-making, especially in fields like tourism, where factors like satisfaction, motivation, and destination image are frequently subjective and vary across individuals.

Fuzzy set membership

Fuzzy sets allocate for classifying attributes based on degrees of membership rather than discrete categorizations. The membership function $\mu B(y)$ assists in establishing the measure to which an element y belongs to a fuzzy set B. It can be expressed in *Eq. (1)*.

$$\mu B(y) = \frac{1}{1 + \left(\frac{y - b}{a}\right)^m}, \tag{1}$$

where, $\mu B(y)$ is the membership function for fuzzy set B, a and b are parameters that control the curve of the membership function, and m is the shape parameter, controlling the slope of the curve. This equation facilitates the classification of customer attributes (e.g., satisfaction, motivation) with varying degrees of truth or membership.

Lower and upper approximations in RST

RST approximates decision classes under uncertainty by defining lower and upper approximations. These approximations can help determine which elements belong or don't belong to a decision class. The approximations in RST can be expressed in *Eqs. (2)* and *(3)*.

$$O_{cl}(s \geq) = \{y \in V \mid C_o(y) \subseteq cl(s)\}, \quad (2)$$

and

$$O_{cl}(s \leq) = \{y \in V \mid C_o(y) \cap cl(s) \neq \emptyset\}, \quad (3)$$

where, $O_{cl}(s \geq)$ and $O_{cl}(s \leq)$ denote the lower and upper approximation, respectively. The class $cl(s)$ represents the lower approximation, and the upper one belongs to the class but is uncertain. These approximations are crucial for understanding customer behaviors and intentions under uncertain conditions. This integration of RST with fuzzy logic can improve the robustness of the research, offering more accurate models and decision rules to recognize customer behavior in sustainable tourism, particularly when data is blurred or uncertain.

3.1.2 | FDM

An expansion of the traditional Delphi technique, the FDM incorporates fuzzy set theory to describe the degree of ambiguity in expert judgments. The consideration of applying FDM in group decision-making accommodates the fuzziness emerging from the different interpretations of the perspectives of experts accordingly. The method works exceptionally well in appraising inherently subjective factors like customers' satisfaction, motivation, and destination image in tourism, which are bound to differ from one individual to the other. The Fuzzy Analytical Hierarchy Process (FAHP) also exemplifies that many concepts in the real world, particularly in sustainable tourism, bear fuzziness by nature.

In the FAHP, decision-makers' judgment is expressed in terms of fuzzy numbers and membership values rather than precise ones, allowing for a more nuanced and flexible approach to decision-making under uncertain conditions. This synergy between the FDM and FAHP helps build an adequate decision framework for sustainable tourism by accounting for and managing the vagueness and complexity of expert and consumer judgments.

The qualitative inputs provided by the 21 experts were integrated with quantitative survey data through the rough set-fuzzy method, which admits that there is uncertainty and imprecision in both data types. The qualitative expert inputs are fuzzy values scales of measurement converted into numerical survey data. RST is then employed to handle the uncertainty in the combined data set, finding significant patterns and relationships linking fuzzy expert assessments and quantitative survey responses. This results in the extraction of rules through which the data is well defined so that the differences between subjective expert opinions and objective survey data are bridged close to accurate analysis.

3.2 | Qualitative Research

Qualitative research analysis utilizing the rough set Delphi theory and fuzzy Delphi technique aims to gather expert consensus on the purchase intention of sustainable tourism destination tour packages on social media in Thailand [60], [61]. This analysis follows a structured four-step approach. *Fig. 3* represents the structured four-step process of the qualitative approach.

To measure the dimensions of suitability and practicality following the collection of expert opinions, RSTD analysis was applied to assess the level of consensus among experts. Each expert provided numeric ratings for the two criteria, which were then systematically analyzed to determine the degree of agreement across responses. Ratings consistently analyzed with the range of 5 to 7 indicated strong agreement among experts. These were, therefore, categorized into the lower approximation, representing complete agreement with a decision value of $d = 1$. In contrast, when the ratings analyzed between 1 and 4 reflected a lack of consensus and were placed in the Upper Approximation, corresponding to a decision value of $d = 0$, indicating complete disagreement. These approximations enabled the identification of well-defined versus ambiguous cases, offering a structured framework to distinguish clear consensus from variability in expert judgment. The final result of this process was the transformation of subjective expert ratings into binary values, either 1 or 0,

which were then utilized as organized input data for the subsequent fuzzy transformation phase in the analysis model.

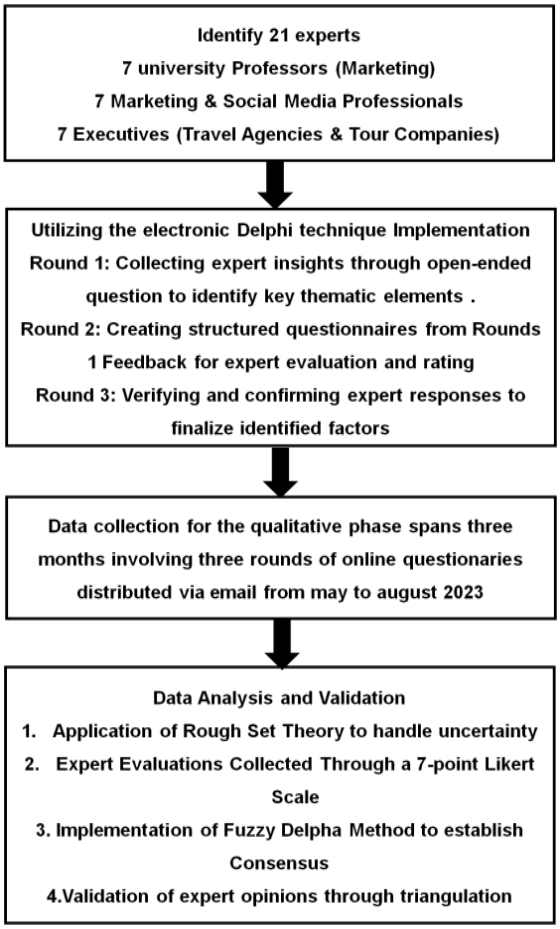

Fig. 3. Architectural framework of qualitative research.

3.2.1 | Population and sampling

To reach an expert consensus on purchase intention for sustainable tourism destination tour packages on social media in Thailand. The examiner divided the participants into three groups: Group 1 comprises seven professionals in marketing and social media with at least two years of work experience or certification from online platforms like Line, Facebook, TikTok, etc. Group 2 consists of seven executives from travel agencies or domestic tour companies, all of whom work for companies that have been operational for over five years. Finally, there are seven university professors, all of whom specialize in business administration and marketing, each with at least two years of experience in teaching.

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which were then utilized as organized input data for the subsequent fuzzy transformation phase in the analysis model.

3.2.2 | Research instruments

A research-designed tool was used to gather extensive data through an online questionnaire. In the first phase, open-ended questions were used to identify and extract the main thematic concepts from expert assessments. In the second phase, experts transformed this process to systematically evaluate and rate the factors. By adopting a dual-phase approach, researchers could conduct both qualitative exploratory and quantitative assessments of expert opinions while maintaining data collection with methodological rigor.

3.2.3 | Data collection

A mixed-method approach was used to collect the data, incorporating qualitative and quantitative techniques to ensure comprehensive construct development and validation. During the qualitative phase between May and August 2023, three rounds of online questionnaires were distributed through email to 21 selected experts from the fields of tourism, marketing, and academia. The inputs were analyzed using an RSFD hybrid model to identify and refine the key determinants influencing SPI. In the quantitative phase, a structured survey was administered to 850 participants selected through simple random sampling distributed via social media platforms. This survey aimed to validate the constructs using CFA statistically, thus reinforcing the robustness and applicability of the implemented approach in Thailand's sustainable tourism context.

3.2.4 | Data analysis

RST and fuzzy Delphi techniques were used as a hybrid analytical methodology for assessing expert consensus data. The innovative aspect of this approach is that it improves the accuracy of expert opinion analysis while reducing uncertainties in the decision-making process. Below is a detailed four-step analysis followed by an evaluation of the expert consensus data. Such complementary techniques improve the precision and reliability with which expert opinion analysis can be incorporated. *Fig. 4* represents the expert consensus analysis process.

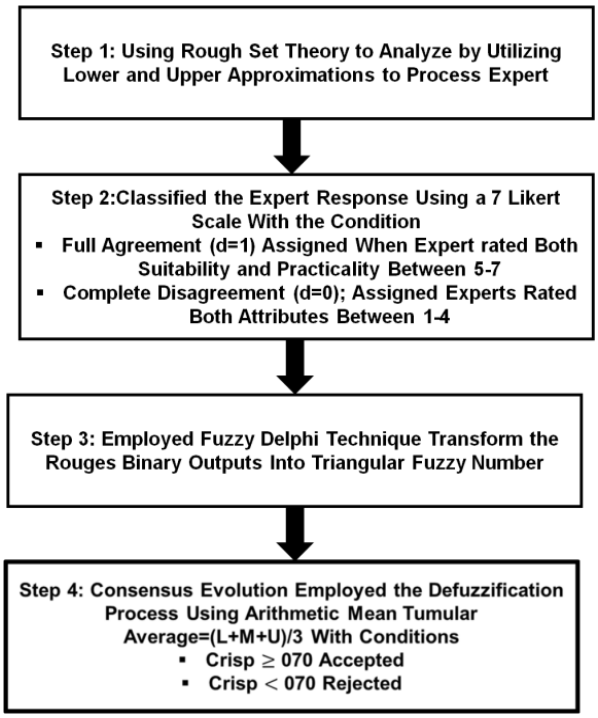


Fig. 4. Expert evaluation process using rough set and FDMs [62].

Step 1. The work commenced by employing RST, where boundary region definitions were used, i.e., Lower Approximation = $\{x \in U: [x]R \subseteq X\}$ and Upper Approximation = $\{x \in U: [x]R \cap X \neq \emptyset\}$. Two rules for

suitability and practicability attributes based on the decision process were employed. Complete disagreement (d = 0) was defined by scores in [1, 4], which corresponded to the top approximation, and full agreement (d = 1) was defined as both characteristic scores falling with [5, 7], indicating lower approximation. This mathematical framework supports the systematic processing of expert opinions under the uncertainty inherent in expert responses. *Fig. 5* depicts the structure of RST.

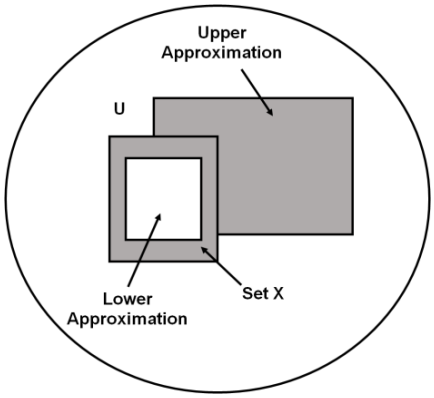


Fig. 5. Representation of RST approximations [62].

Fig. 5 illustrates the concept of approximations included in RST. The universal set U encompasses all possible elements, while set X is the target subset. The lower approximation contains all elements that definitely belong to Set X. In contrast, the upper approximation comprises elements that might possibly belong to set X. The difference between these two forms the boundary region, which reflects the uncertainty and vagueness present in incomplete or imprecise information.

Step 2. The categorization of expert evaluations on 7-point Likert scale was done according to binary decision rules: Binary classification (Agree = 1, disagree = 0) was utilized following the standard decision rule in RST, which tolerates clear differentiation under uncertain conditions [41]. This method improves interpretability by clearly defining agreement and disagreement thresholds, essential for expert consensus analysis.

Table 1 presents the categorization of evaluations. While binary rules provide clarity and robustness in rule generation, future research can consider integrating multi-valued or probabilistic decision rules to reflect varying degrees of expert opinion better, especially when using Likert-scale responses.

Table 1. Rought set condition rule.

Decision Type	Condition
Total disagreement (d=0)	Both attribute ratings: 1-4
Completed agreement (d=1)	Both suitability and practicality rating: 5-7

Step 3. The fuzzy Delphi technique, a variant of the conventional Delphi method that integrates fuzzy set theory, was used in the secondary phase to address the vagueness in expert judgment. The triangle membership function facilitates the computations required for this method, as shown in *Fig. 6*.

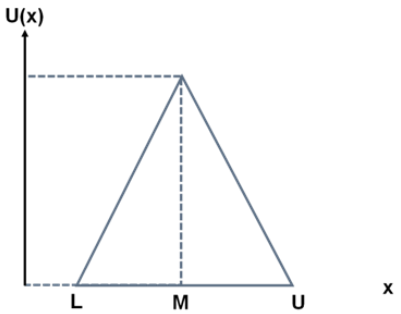


Fig. 6. Triangular fuzzy number membership function representation [62].

Fig. 6 illustrates the Triangular Fuzzy Number (TFN) membership function. This function is utilized to signify imprecise or subjective information in fuzzy set theory. Fuzzy Set is represented as F = (L, M, U) where L is the smallest numerical value of a fuzzy member, M is the largest numerical value of a fuzzy member, and U is the highest membership degree of the set.

This process converts the binary outputs from the rough set analysis into TFN using the following parameters. TFN conversion from binary outputs such as agree (1) and disagree (0) to fuzzy scores to account for the uncertainty and different measures of true/false when developing expert opinions.

The value of agree is [0.50, 0.75, 1.00], which shows a fuzzy scale where agreement is 0.50 (A moderate degree of agreement), 0.75 (Partial agreement), and finally, complete agreement at 1.00. The value of disagree is [0.00, 0.25, 0.50], illustrating a fuzzy range that starts with total disagree at 0.00, then partial disagree at 0.25, and moderate disagree at a level of 0.50.

The fuzzification allows the conversion of binary data into a representation that is reflective in different degrees of certainty or uncertainty, which connects with the context of binary classifications and rarely fully represents the complexities of an expert's opinion.

The triangular number function is defined specifically by three variables, the Lower (L), Middle (M), and Upper (U) point estimates that correlate as membership at 0, low level as L, mid-level as M, and full membership at U. *Fig. 7* shows the fuzzification process and provides considerable information about how the raw binary data is converted into fuzzy values.

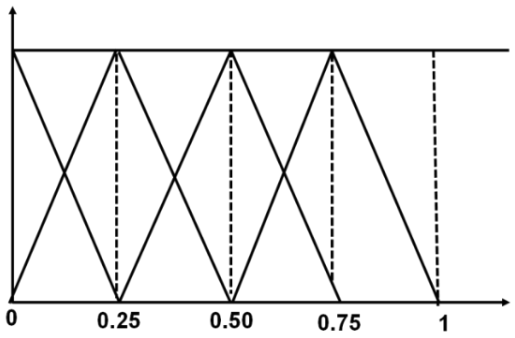


Fig. 7. Fuzzy set-based factor selection using membership functions [62].

Fig. 7 expresses the selection of factors using fuzzy theory, where overlapping triangular membership functions were utilized to define fuzzy linguistic variables across a normalized range from 0 to 1.

Table 2. Illustrates the parameters for TFN.

Rough Result Output	Lower (L)	Middle (M)	Upper (U)
Disagree = 0	0.00	0.25	0.50
Agree = 1	0.50	0.75	0.00

The TFN parameters described in *Table 2* are based on common practices in the fuzzy Delphi. For example, the triangular dispersions [0.00, 0.25, 0.50] were used to indicate "disagree," and [0.50, 0.75, 1.00] were used to indicate "agree". This is a common method for employing a fuzzy representation of expert consensus through linguistic variables. This representation allows for structured quantification of qualitative judgment with the midpoint (e.g., 0.75) as the most likely value, and the lower and upper bounds (0.50 and 1.00) are two separate representations of uncertainty surrounding this estimate. These parameters of TFN are especially useful in aggregating and defuzzifying expert opinion, which can not only consider subjective and imprecise factors as expressed in the rating but also quantify the uncertainty associated with a rating. By employing a TFN framework and using a methodology consistent with previous FDM applications, the research provides a reliable framework for measuring consensus and interpreting expert ratings.

The TFN parameters (e.g., 0.25, 0.50, 0.75) utilized in this research were adopted following standard practices in fuzzy Delphi and fuzzy rough set literature [14], [61]. These values symbolize changeable levels of agreement and are widely accepted in expert-based decision-making models. The defuzzification formula represents the centroid method, a widely used technique in fuzzy logic for converting fuzzy sets into crisp values by averaging the boundaries and the peak of the fuzzy triangle [14].

Step 4. In this step, defuzzification was performed using the following *Eq. (4),* commonly known as the centroid method.

$$\text{Centroid} = \frac{(\text{L} + \text{M} + \text{U})}{3}. \quad \textbf{(4)}$$

A defuzzification threshold of 0.70 was chosen based on prior fuzzy Delphi research, which suggests this value is a suitable benchmark for achieving expert consensus [60]. This threshold ensures that only factors with strong agreement among experts are retained, aligning with best practices in fuzzy-based decision-making.

The centroid approach is used in defuzzification to identify the fuzzy set's center of mass. Utilizing the membership degrees of the output values generates a clear value represented by the weighted average of the output values. Considering that the crisp value is irreversible, the average output value in relation to the membership values of the fuzzy set represents its output. The centroid can be found analytically by integrating the product of the variable and its corresponding membership function over the whole range of possible output values. The centroid method is the most employed, as it is simple and gives a crisp value concerning the area under the fuzzy curve as it produces a final output.

Based on accepted RSFD norms, the defuzzification process's threshold value of 0.70 was developed. This criterion is frequently employed to demonstrate a legitimate degree of agreement among the members of an expert panel. Specifically, when the defuzzified number is more than 0.70, it means that most respondents strongly agree with a given item or statement. This ensures that only items with a high collective agreement are kept for additional examination. It can eliminate unclear or poorly supported responses by employing a 0.70 cutoff criterion, producing a more targeted and consensus-driven result.

3.3 | Quantitative Research

An existing model of purchase intention on social media for sustainable tourism packages in Thailand was developed and validated using a quantitative methodology based on qualitative results from expert consensus. The process of transforming the seven factors and thirty-one variables into a structured online questionnaire was performed, and 893 people who purchased tour packages in Thailand were involved in the research by distributing the questionnaire.

3.3.1 | Population and sampling

The selection of the sample population was attributable to the ground that participants had bought the tour packages at least once. The group also comprised people who had paid for those packages via social media platforms in Thailand. To establish statistical guidelines, which advised having at least 10 to 20 participants per observed variable and 200 or more participants for the valid model, the research's 27 observable variables need at least 270 participants. Finally, the research received 850 valid responses, much more than the minimum required to provide a robust statistical foundation for the research of the causal relation model.

3.3.2 | Research instruments

A systematic online questionnaire was used to identify 31 variables and seven validated factors based on expert consensus. Respondents rated their level of agreement using a 7-point Likert scale ranging from 1 (Strongly disagree) to 7 (Strongly agree). Aligned with the theoretical framework, this approach assists in systematically collecting quantitative data. Effective data gathering was made possible by the extensive measurement instrument.

3.3.3 | Data collection

A hybrid approach is used to gather the data, incorporating qualitative and quantitative techniques to ensure comprehensive construct development and validation. During the quantitative phase, conducted between October and December 2024, three rounds of online questionnaires were distributed via email from the fields of tourism, marketing, and academia. The inputs were analyzed using an RSFD hybrid model to identify and refine the key determinants influencing SPI. In the quantitative phase, a structured survey was administered to 850 participants selected through simple random sampling distributed via social media platforms. This survey aimed to statistically validate the constructs using CFA, thereby reinforcing the proposed model's robustness and applicability in Thailand's sustainable tourism context.

3.3.4 | Analysis of data

For this research, data analysis was performed with a holistic approach, followed by applying CFA to evaluate the measurement model's goodness of fit. This was done through the CFA phase, where various individual constructs were systematically examined through first-order and second-order factor analyses, and subsequent fit indexes were used for confirmation.

Specifically, Chi-square Minimum (CMIN)/Degrees of Freedom (DF) ≤ 3.0; Comparative Fit Index (CFI), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), and Tucker-Lewis Index (TLI) were applied that are having values of at least 0.9 and Root Mean Square Error of Approximation (RMSEA) and Root Mean Square Residual (RMR) both 0.08 or less [63–65]. Moreover, the accepted criteria for existing constructs consisted of factor loading ≥ 0.70 and Composite Reliability (CR) ≥ 0.70 [72]. The Average Variance Extracted (AVE) value was ≥ 0.50 [72]. The Cronbach's Alpha (CA) value was ≥ 0.70, and $R^2 \geq 0.20$.

4 | Results

4.1 | Expert Consensus on Evaluations

The variables are validated according to the final Composite Reliability Index for Panels (CRIP) results from the analysis. The classification of variables as Acceptable was based on a statistically defined defuzzification threshold of 0.70, which reflects expert consensus as quantified through the FDM. Rather than purely subjective, this threshold represents a convergence of expert judgment processed through a fuzzy logic framework, ensuring that accepted variables exhibit a high level of agreement across all evaluators.

This approach aligns with established methodological practices in fuzzy Delphi [60]. As per the expert panel, each variable's validation results are presented in *Table 3*.

Table 3. Expert consensus result.

Question	Average			Crisp	Result
PTI					
1. Do you think that tourism in Thailand leads to greater cultural exchange and learning?	0.50	0.75	1.00	0.750	Acceptable
2. Do you think that tourism in Thailand facilitates the continuous sharing of cultural knowledge?	0.50	0.75	1.00	0.750	Acceptable
3. Do you think that tourism in Thailand improves the quality of life for people in the community?	0.48	0.73	0.98	0.726	Acceptable
4. Do you think that tourism in Thailand leads to improvements in the environment, making communities more livable?	0.50	0.75	1.00	0.750	Acceptable

Table 3. Continued.

Question	Average			Crisp	Result
PSQ					
1. Do you think that the admin provides accurate responses to questions about travel packages in Thailand?	0.50	0.75	1.00	0.750	Acceptable
2. Do you think the admin offers complete answers to questions about travel packages in Thailand?	0.50	0.75	1.00	0.750	Acceptable
3. Do you think the admin provides quick responses to questions about travel packages in Thailand?	0.50	0.75	1.00	0.750	Acceptable
4. Do you think the admin provides up-to-date information about travel packages in Thailand?	0.50	0.75	1.00	0.750	Acceptable
E-WOM (EWM)					
1. You often share positive comments about travel packages in Thailand on social media.	0.50	0.75	1.00	0.750	Acceptable
2. You often share positive experiences about travel packages in Thailand on social media.	0.48	0.73	0.98	0.726	Acceptable
3. You often share information about travel packages in Thailand on social media.	0.50	0.75	1.00	0.750	Acceptable
4. You often recommend that others purchase travel packages in Thailand on social media.	0.50	0.75	1.00	0.750	Acceptable
Motivation (MTV)					
1. You want to travel to Thailand to meet and socialize with friends or family.	0.50	0.75	1.00	0.750	Acceptable
2. You want to travel to Thailand for fun and enjoyment.	0.50	0.75	1.00	0.750	Acceptable
3. You want to travel to Thailand to experience nature.	0.50	0.75	1.00	0.750	Acceptable
4. You want to travel to Thailand to learn about the local people's way of life.	0.50	0.75	1.00	0.750	Acceptable
Satisfaction (SAT)					
1. You feel satisfied with the images of tourist destinations in Thailand through social media.	0.50	0.75	1.00	0.750	Acceptable
2. You are satisfied with the social media videos of Thailand's tourist attractions.	0.50	0.75	1.00	0.750	Acceptable
3. The extensive information about Thailand trip packages on social media makes you happy.	0.48	0.73	0.98	0.726	Acceptable
4. You feel satisfied with the after-sales service of travel packages in Thailand on social media.	0.50	0.75	1.00	0.750	Acceptable
Loyalty (LYT)					
1. Can you repurchase travel packages in Thailand on social media again in the future?	0.50	0.75	1.00	0.750	Acceptable
2. When you want to buy a travel package in Thailand, you think of purchasing it on social media first.	0.50	0.75	1.00	0.750	Acceptable
3. You can recommend your acquaintances to purchase travel packages in Thailand from social media platforms.	0.50	0.75	1.00	0.750	Acceptable
4. You share the value of purchasing travel packages in Thailand on social media.	0.48	0.73	0.98	0.726	Acceptable
Destination image (DTI)					
1. Do you think the tourist destinations in travel packages for Thailand on social media are well known?	0.50	0.75	1.00	0.750	Acceptable
2. Do you think the tourist destinations in travel packages for Thailand on social media offer a variety of activities?	0.48	0.73	0.98	0.726	Acceptable
3. Do you think the tourist destinations in travel packages for Thailand on social media provide an environment that helps relieve stress?	0.48	0.73	0.98	0.726	Acceptable
4. Do you think the tourist destinations in travel packages for Thailand on social media have beautiful scenery?	0.48	0.73	0.98	0.726	Acceptable

Expert consensus regarding the factors influencing Thailand travel packages, including PTI, PSQ, EWM, MTV, SAT, LYT, and DTI, is illustrated in *Table 3*.

Each factor has been rated by participatory experts with a Triangular Fuzzy Membership Function, with 0.50 (Lower agreement) to 1.00 (Full agreement). For instance, the PTI section of *Table 3* illustrates expert agreement by identifying that tourism in Thailand had PIT based on agreement regarding cultural exchange, community quality of life, and environmental improvements.

With the PTI category, responses were all within "acceptable" ranges, which evaluate service quality, satisfaction, loyalty, and destination image. The general agreement emphasizes the positive implications for tourism in Thailand related to multiple areas.

4.2 | Results of Descriptive Statistics and Details Survey Respondents

Descriptive statistics refers to statistical methods applied to summarize, organize, and describe the main features of a data set. These include techniques like frequency, percentage, mean, median, standard deviation, and range to comprehend the distribution and central tendency of the data in question.

Descriptive statistics were carried out to comprehend the participants' demographic background in the survey data. Eight hundred fifty respondents from diverse ages, genders, educational backgrounds, and regions participated in the converse survey.

The analysis shows that the distribution of participants across key demographic variables was ensured to be representative across various categories. *Table 4* depicts the detailed distribution of respondents' characteristics.

Table 4. Count and percentage of respondents.

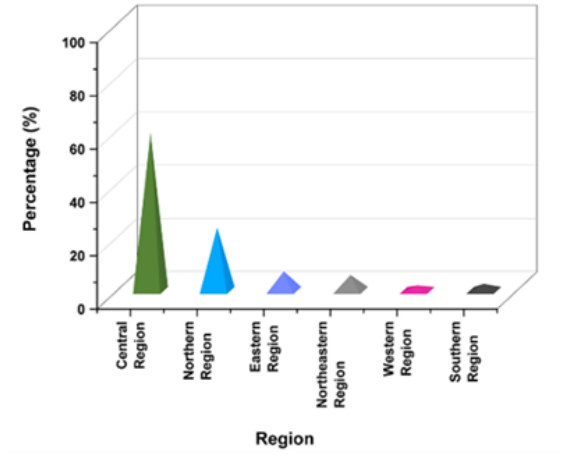
Variables	Quantity	Percentage
Gender		
- Female	342	40.2
- Male	490	57.6
- Other	18	2.1
Age		
Between 18 and 30 years	112	13.2
Between 31 and 45 year	562	66.1
Between 46 and 60 year	90	10.59
Between 61 to 80 years	86	10.20
Education level		
- Associate degree	5	0.6
- Bachelor's degree	365	42.9
- Master's degree	397	46.7
- Doctoral degree	83	9.8
Region		
-Central region	502	59.1
-Northern region	201	23.6
- Eastern region	61	7.2
- Northeastern region	49	5.8
- Western region	16	1.9
- Southern region	21	2.5

Table 4 reports demographic information stratified by gender, age, education level, and location. In terms of gender, the majority (57.6%) of the participants identified as male, while approximately two-thirds of respondents identified as female (40.2%) or other (2.1%).

In the category of age computation, the majority of respondents (66.1%) were 31 to 40 years of age, followed by 20.7% who were between 41 to 80 years of age and 13.2% between 18 to 30 years of age. In terms of education, less than half (42.8%) of respondents had a bachelor's degree; respondents with a master's were 46.7%, respondents with a doctoral degree were 9.8, and only 0.6% had an associate's degree.

For location, many respondents were from the central region (59.1%), with a smaller percentage being from other regions. Though this demographic information gives a somewhat basic foundation of participant

characteristics, the data can be further contextualized so that it can address the contexts of research objectives or findings. *Fig. 8* depicts the graphical illustration of the variables.



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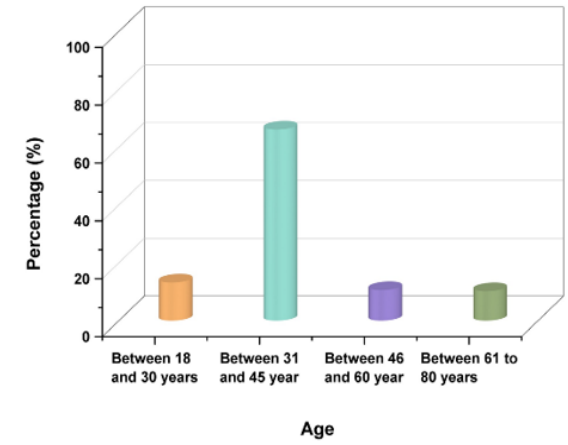

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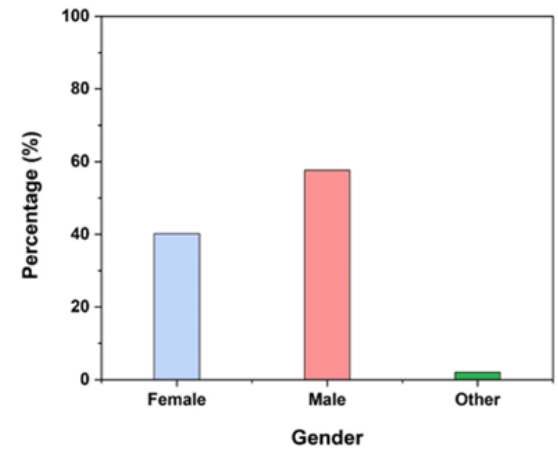

c.

Fig. 8. Graphical representation of demographic variables; a. region, b. age, and c. gender.

4.3 | Confirmatory Factor Analysis Test Result for Each Contract

The RMSEA and RMR values are reported as 0.00, as shown in *Table 5*. Although, at first glance, these values appear statistically perfect, they can occur for legitimate statistical reasons. Those values are usually found in

saturated or near-saturated models where the number of parameters estimated is similar to the number of observed variances and covariance, which causes the sum of the residuals to be small in comparison.

TCC for the CFA model was intended for three well-validated constructs, which were determined by a consensus of four experts who made up the total construct of TCC. Thus, the TCC demonstrated high internal consistency and low error variance. Also, the large sample size (n = 850) adds to the stability of the model as the likelihood of reducing any estimation error or unexplained residual. With all of these characteristics together, it is possible to produce values of RMSEA and RMR that are extremely low or even zero.

CFA is a statistical technique used to test whether a set of practical variables reliably and validly measures the latent constructs such as PTI, PSQ, EWM, MTV, SAT, LYT, and DTI that are deliberate to characterize. CFA was conducted to confirm the validity of the measurement model. The relationships between observed variables and the respective latent constructs were evaluated through CFA. The reliability and validity of the measurement items and the indicators were assessed using CA, Composite Reliability (CR), AVE, and model fit indices.

Table 5. CFA test result.

Latent Variables and Indicators	Measurement	PTI	PSQ	EWM	MTV	SAT	LYT	DTI
CA	> 0.7	0.92	0.93	0.93	0.94	0.94	0.94	0.94
Cr	> 0.7	0.92	0.93	0.93	0.94	0.94	0.94	0.95
Ave	> 0.5	0.76	0.76	0.77	0.80	0.80	0.82	0.82
√ Ave (Fornell-larcker criterion)	√ Ave	0.87	0.87	0.88	0.89	0.89	0.91	0.91
CMIN/df	≤ 3	2.98	0.39	0.79	0.83	0.45	2.65	0.83
RMR	≤ 0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RMSEA	≤ 0.8	0.04	0.00	0.00	0.00	0.00	0.04	0.00
CFI	≥ 0.9	0.99	1.00	1.00	1.00	1.00	0.99	1.00
GFI	≥ 0.9	0.99	1.00	1.00	0.99	1.00	0.99	1.00
AGFI	≥ 0.9	0.98	0.99	0.99	0.99	0.99	0.98	0.99
TLI	≥ 0.9	0.99	1.00	1.00	1.00	1.00	0.99	1.00
Result		Fit	Fit	Fit	Fit	Fit	Fit	Fit

Several latent variables, such as PTI, PSQ, EWM, MTV, SAT, LYT, and DTI, are tested using the CFA method. A range of fit metrics and indices are offered to assess model appropriateness. Good internal consistency is shown by all variables meeting the necessary levels for CA (≥ 0.7), CR (Cr ≥ 0.7), and AVE (AVE ≥ 0.5). All variables have values above the threshold for the Fornell-Larcker Criterion, guaranteeing discriminant validity. The fit indices confirm the model's goodness of fit, including CMIN/df, RMSEA, CFI, GFI, AGFI, and TLI, all of which reach or surpass the acceptable cutoffs. Although more context is required to comprehend the larger research's implications fully, these results imply that the measurement model is reliable and well-fitting.

4.4 | First-Order Confirmatory Factor Analysis

CFA of the first order is a prerequisite before proceeding to the second-order tests in a structural equation model. Among other purposes, it aids in: First, this initial analysis offers basic validation of the measurement model by examining whether the measured variables precisely measure the proposed constructs and by obtaining validity and reliability results from the first-order CFA.

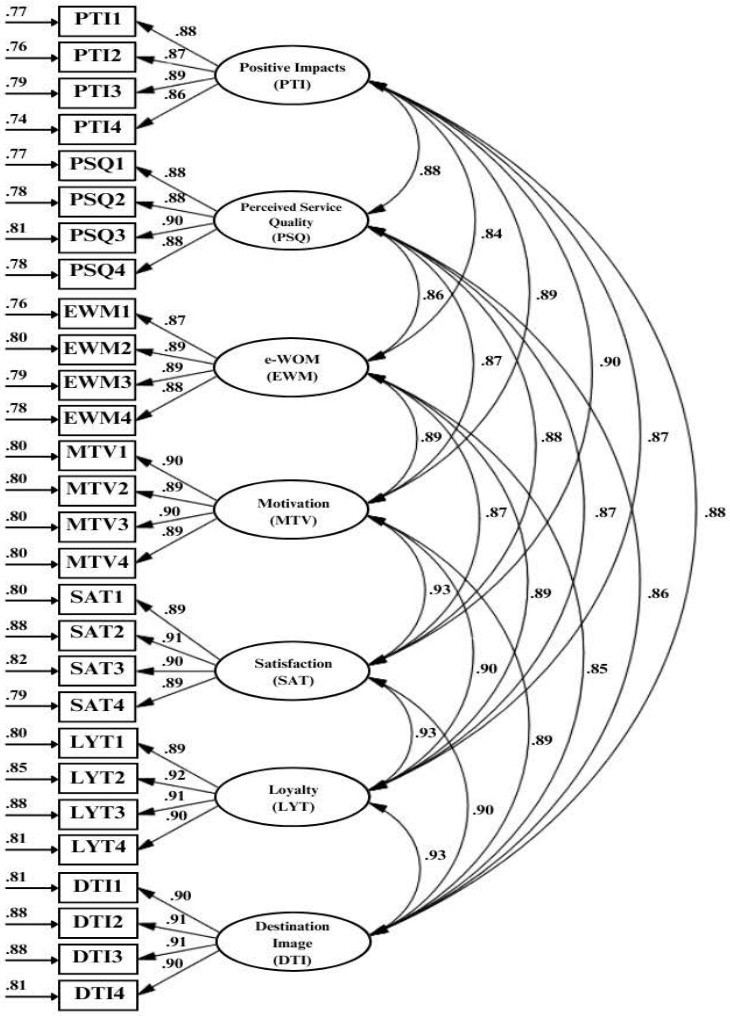

Fig. 9. Structural model of key constructs influencing tourist loyalty.

The SEM results presented in *Fig. 9* reveal the relationship among the major variables. Constructs are represented by multiple indicators shown by the factor loadings (e.g., PTI1–PTI4). The paths in these latent constructs suggest hypothesized relationships, with the values representing standardized regression weights. Model fit shows strong internal consistency, with most of the factor loadings exceeding 0.70, and the inter-construct correlations indicate a strong influence on how these considerations regarding service quality are perceived, evaluated against motivational dimensions, and linked to satisfaction and destination loyalty.

Table 6. Illustrates the fit indices for first-order confirmatory factors.

Index	Measurement	Statistics Gathered	Result
CMIN/df	≤ 3	1.92	Fit
RMR	≤ 0.8	0.01	Fit
RMSEA	≤ 0.8	0.03	Fit
CFI	≥ 0.9	0.99	Fit
GFI	≥0.9	0.95	Fit
AGFI	≥ 0.9	0.94	Fit
TLI	≥ 0.9	0.98	Fit

Table 6 presents a table of model fit indices in first-order CFA. Each index meets its respective threshold, indicating a good model fit. The indices include CMIN/df ≤ 3 at 1.92, RMR ≤ 0.8 at 0.01, RMSEA ≤ 0.8 at 0.03, CFI ≥ 0.9 at 0.99, GFI ≥ 0.9 at 0.95, AGFI ≥ 0.9 at 0.94, and TLI ≥ 0.9 at 0.98. All results indicate a fit.

The fit indices for the first-order confirmatory factors were collected, and the model was demonstrated to be adequate. There was a good model fit in all of the gathered statistics for each index. The CMIN/df statistics

(1.92) is below the acceptable level of 3 and indicates an appropriate chi-square per degree-of-freedom ratio. The RMSEA (.03) in the acceptable level (0.8) demonstrates an acceptable model approximation. Values for CFI (0.99), GFI (0.95), AGFI (0.94), and TLI (0.98) were all above the bare minimum that was deemed appropriate (0.9), which provides additional evidence for the model demonstrating good fit. The measurement model adequately describes; however, more contexts about the latent variables and relationships can help understand the larger umbrella with the research results.

Table 7. Outcomes of fit indices for first-order CFA.

Construct	Item	Factor Loading	S.E.	C.R.	P	R^2
PTI	PTI1	0.88	0.02	35.20	***	0.59
	PTI2	0.87	0.02	36.10	***	0.61
	PTI3	0.89	0.02	34.00	***	0.55
	PTI4	0.86	0.02	36.50	***	0.61
PSQ	PSQ1	0.88	0.02	34.60	***	0.58
	PSQ2	0.88	0.02	35.90	***	0.61
	PSQ3	0.90	0.02	35.30	***	0.59
	PSQ4	0.88	0.02	33.90	***	0.56
E-WOM (EWM)	EWM1	0.87	0.02	37.80	***	0.66
	EWM2	0.90	0.02	38.20	***	0.67
	EWM3	0.89	0.02	37.10	***	0.64
	EWM4	0.88	0.02	37.00	***	0.64
Motivation (MTV)	MTV1	0.90	0.02	39.60	***	0.71
	MTV2	0.89	0.02	39.00	***	0.69
	MTV3	0.90	0.02	38.90	***	0.69
	MTV4	0.89	0.02	38.00	***	0.66
Satisfaction (SAT)	SAT1	0.89	0.02	42.30	***	0.81
	SAT2	0.91	0.02	43.10	***	0.83
	SAT3	0.90	0.02	42.00	***	0.81
	SAT4	0.89	0.02	43.20	***	0.83
Loyalty (LYT)	LYT1	0.89	0.02	41.50	***	0.81
	LYT2	0.92	0.02	42.80	***	0.83
	LYT3	0.91	0.02	42.90	***	0.83
	LYT4	0.90	0.02	42.00	***	0.81
Destination Image (DTI)	DTI1	0.90	0.02	38.00	***	0.66
	DTI2	0.91	0.02	38.40	***	0.67
	DTI3	0.91	0.02	38.50	***	0.67
	DTI4	0.90	0.02	38.00	***	0.66

Table 7 represents the indices of the first-order CFA, showing that all seven-factor loadings in the model were higher than 0.7. Strong explanatory power was demonstrated by the model's high R-squared values, which show that a significant portion of the variation is explained. Internal consistency was further demonstrated by the fact that all of the constructions' CA scores were above the cutoff (>0.7).

The residual measurements showed minimal difference between the observed and model-implied matrices. These results comprehensively validate the reliability and variable validity of the measurement model for sustainable tourism package purchases in Thailand.

4.5 | Second-Order Confirmatory Factor Analysis

A CFA of the first order is a requirement before running second-order tests in a structural equation model. This initial analysis serves several purposes, including validating the measurement model by examining whether the measured variables precisely assess proposed constructs and determining the instrument's validity and reliability using the first-order CFA. *Fig. 10* shows the second-order confirmatory analysis.

SEM defines the direct effects of several latent constructs on SPI. Along with strong factor loadings, multiple observed variables measure each construct that is shown to represent reliable measures. It is clear from the model that there are significant positive path coefficients from all constructs to SPI.

Hence, the factors are critical drivers of the consumers' sustainable purchasing behavior in tourism contexts. The high values of the standardized regression weights lend empirical support for the explanatory power of this model and the robustness of the proposed framework.

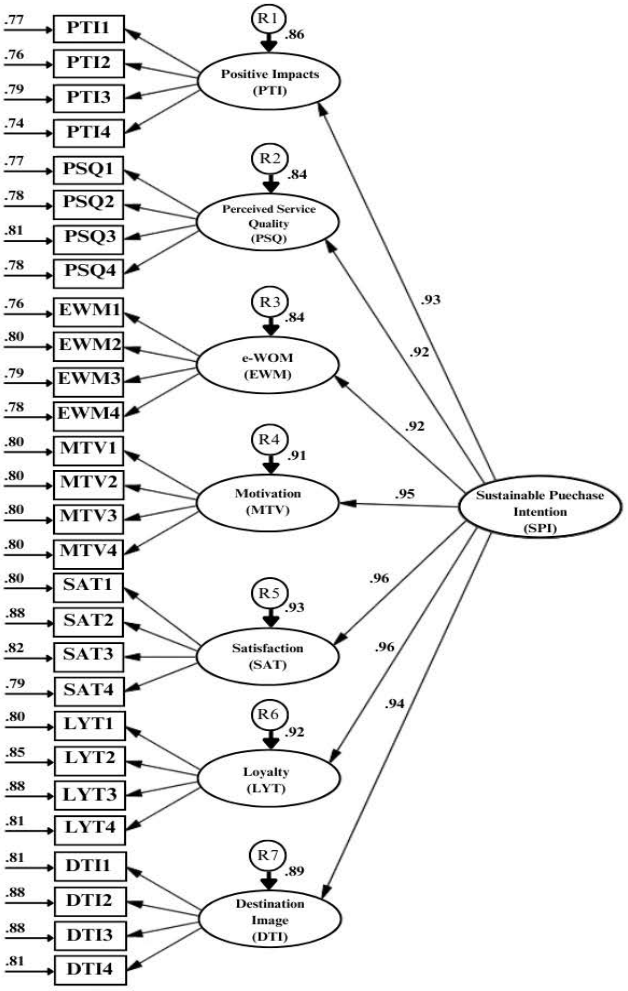

Fig. 10. Representation of second-order CFA.

Table 8. Illustrates the fit indices for second-order CFA.

Index	Measurement	Statistics Gathered	Result
CMIN/df	≤ 3	2.20	Fit
RMR	≤ 0.8	0.01	Fit
RMSEA	≤ 0.8	0.03	Fit
CFI	≥ 0.9	0.98	Fit
GFI	≥ 0.9	0.94	Fit
AGFI	≥ 0.9	0.93	Fit
TLI	≥ 0.9	0.98	Fit

Fit indices for the second-order CFA in *Table 8* assess how well the second-order model's fit is evaluated. A CMIN/df value of 2.20 (a value of 3 is acceptable) indicates a relative fit of the model to the data. An RMR value of 0.01 is well below an acceptable level of 0.8, indicating slight residual variance. The value of RMSEA is 0.03, which is permissible because the acceptable level of 0.8 indicates a good fit for the model. The confirmation of the strong fit of the second-order model can also be seen with the adequacy of the CFI = 0.98, GFI = 0.94, AGFI = 0.93, and TLI = 0.98, all of which exceed the criterion of 0.9. All the fit indices reported suggest that a reliance on the second-order CFA was analyzed. Information about the model structure can also aid interpretation.

A table of model fit indices in second-order CFA is presented in *Table 9*. Each index meets its respective threshold, indicating a good model fit. The indices include CMIN/df ≤ 3 at 2.20, RMR ≤ 0.8 at 0.03, RMSEA ≤ 0.8 at 0.03, CFI ≥ 0.9 at 0.98, GFI ≥ 0.9 at 0.94, AGFI ≥ 0.9 at 0.93, and TLI ≥ 0.9 at 0.98. All results indicate a fit.

Table 9. Outcomes of fit indices.

Items	Variables	S.E.	C.R.	P	R^2
PTI	0.93				0.86
PTI 1	0.88				
PTI 2	0.87	0.02	34.71	***	
PTI 3	0.89	0.02	34.12	***	
PTI 4	0.86	0.02	35.66	***	
PSQ	0.92				0.84
PSQ 1	0.88	0.02	36.62	***	
PSQ 2	0.88	0.02	36.83	***	
PSQ 3	0.90	0.02	38.66	***	
PSQ 4	0.88				
E-WOM (EWM)	0.92				0.84
EWM 1	0.87				
EWM 2	0.90	0.02	36.11	***	
EWM 3	0.89	0.02	38.23	***	
EWM 4	0.88	0.02	37.68	***	
MTV	0.95				
MTV 1	0.90	0.02	39.93	***	
MTV 2	0.89	0.02	39.72	***	
MTV 3	0.90	0.02	40.10	***	
MTV 4	0.89				
SAT	0.96				0.93
SAT 1	0.89	0.02	40.98	***	
SAT 2	0.91	0.02	43.37	***	
SAT 3	0.90				
SAT 4	0.89	0.02	40.74	***	
LYT	0.96				0.92
LYT 1	0.89	0.02	40.52	***	
LYT 2	0.92	0.02	44.04	***	
LYT 3	0.91	0.02	42.88	***	
LYT 4	0.90				
DTI	0.92				0.89
DTI 1	0.90	0.02	41.58	***	
DTI 2	0.91	0.02	42.88	***	
DTI 3	0.91	0.02	43.43	***	
DTI 4	0.90				

Excellent model fit indices were obtained from the second-order CFA, and every result satisfied the acceptable standards. All seven-factor loadings in the model were higher than 0.7, with motivation (0.95), loyalty (0.96), and satisfaction (0.96) having the highest loadings. Strong explanatory power was demonstrated by the model's high R-squared values for satisfaction (0.93) and loyalty (0.92), which show that a significant portion of the variation is explained. Internal consistency was further demonstrated by the fact that all of the constructions' CA scores were above the cutoff (>0.7). There was minimal difference between the observed and model-implied matrices in the residual measurements, and the model fit was excellent (RMSEA = 0.03, RMR = 0.02). These results comprehensively validate the reliability and construct validity of the measurement model for sustainable tourism package purchases in Thailand.

4.6 | Path Analysis

Hypothesis testing was conducted using CFA to evaluate the influence of the identified determinants on customer purchase intention toward sustainable tourism packages in Thailand. This step examined each latent variable's structural validity and predictive strength, which were identified through the RSFD methodology.

The statistical significance of each path was assessed using standardized coefficients (β), Standard Errors (SE), t-values, and p-values. *Table 10* presents the hypothesis testing results, confirming all paths as statistically significant at $p < 0.001$, with satisfaction emerging as the strongest predictor, thus validating its central role in the proposed model.

Table 10. Hypothesis testing results for determinants of purchase intention.

Hypothesis	Pathway	β	SE	t-Value	p-Value	Accepted / Not Accepted
H1	SPI → PTI	0.52	0.03	17.33	0.000	Accepted
H2	SPI → PSQ	0.64	0.04	16.00	0.000	Accepted
H3	SPI → E-WOM	0.61	0.03	20.33	0.000	Accepted
H4	SPI → MTV	0.46	0.02	23.00	0.000	Accepted
H5	SPI → SAT	0.96	0.01	96.00	0.000	Accepted
H6	SPI → LYT	0.70	0.02	35.00	0.000	Accepted
H7	SPI → DIT	0.58	0.03	19.33	0.000	Accepted

Table 10 presents the results of hypothesis testing based on the CFA conducted on the proposed model, which investigates the causal relationships between key determinants and customer purchase intention for sustainable tourism packages in Thailand. All hypothesized paths were found to be statistically significant at the $p < 0.001$ level. Satisfaction demonstrated the most decisive influence on purchase intention, as indicated by the highest standardized regression weight ($\beta = 0.96$), confirming its critical role in the structural model.

5 | Discussion

While previous research by Giampiccoli and Mtapuri [7] and Veilleux and Sarrasin [39] offers valuable insights into sustainable tourism in Southeast Asia, it is primarily conceptual. It lacks quantitative methods to model tourist behavior. In contrast, the present research overcomes limitations by implementing a FR set-based approach, enabling a more precise and data-driven understanding of customer intention under uncertainty. According to the model fit indices, all fit indices were great (CFI = 0.98, GFI = 0.98, RMSEA = 0.03), higher than in previous research like this one. Only 0.93 of the variances in SPI in tourism are explained by satisfaction with factors, indicating that satisfaction is the most potent influence on the tourist's behavior.

This aligns with Seow et al. [66], who highlight the feeling of satisfaction among tourists in their overall travel experience and decision-making process. Farrukh et al. [67] found that a positive destination image is vital in attracting tourists. The second is a similar influence between PSQ and E-WOM, with an R^2 value of 0.84, and both are equally influential. Roy et al. [68] stated that when these factors are added together, tourists in terms of perception, expectation, etc. Finally, including PTI resulted in the decision-making process, but with an R^2 value of 0.86, which means it is a minor component than the decision-making process. While Moisescu [69] finds the benefits to the community and environment extensive, they are indirect and mediated by many other factors, such as satisfaction and loyalty.

The RSF method improves decision-making by merging the ability with data classification of the FDM to a subjective model. RST offers a structured method of clarifying defined or uncertain boundaries via lower and upper approximations. Binary classifications are converted into fuzzy values to capture the nuances associated with agreement levels among expert subjects. This hybrid data approach retains uncertainty while improving the consensus value. Therefore, the RSF is a more accurate basis for a variety of complex decision-making situations, especially in tourism research.

Satisfaction and loyalty enable sustainable tourism by repeatedly prompting consumers to engage in responsible and respectful travel behaviors. When satisfied with sustainable experiences, tourists can advocate and repurchase similar packages, enhancing demand for ethical tourism practices. Stronger allegiance strengthens and cultivates relationships with eco- and socially conscious providers, providing predictable and consistent support for conservation and community-based practices. These behaviors reduce the footprint of tourism on the planet, which can positively impact local economic development. Therefore, these areas offer

a wider range of benefits to tourism associated with general tourism practices, contributing to sustainability objectives.

A fuzzy set is a class of objects with a range of membership grades. A membership function assigns each item in the class a grade between zero and one. Fuzzy sets are used to establish properties of conceptions and to extend concepts such as inclusion, union, intersection, complement, connection, and convexity [70]. In Artificial Intelligence (AI) and cognitive sciences, it is essential for machine learning, knowledge acquisition, pattern recognition, and decision analysis. The primary benefit of RST is that it doesn't require any extra or preliminary data. Bali's sustainable tourism industry shows the necessity to balance environmental preservation and economic growth. It implies that community-based approaches can successfully combine cultural preservation with eco-friendly methods. According to Utama et al. [71], policymakers ought to prioritize community involvement and thorough planning when it comes to sustainable tourism. The Way Kalam Waterfall in Indonesia's Lampung province is managed in large part by the tourism awareness group. Information on organizing, planning, implementing, and monitoring was gathered through interviews and observation. According to the results, the group ensured that members carried out the responsibilities and behaved according to plans by implementing short-, mid-, and long-term planning. However, more effort requires the support of pertinent stakeholders [72].

5.1 | Implications for Thai Tourism Practitioners

The model's field validation is supplemented with expert knowledge from Thai tourism practitioners and the validation of primary data acquired from a sample of 850 domestic travelers who purchased sustainable tourism packages via social media platforms. As two methods are applied, it ensures consistency with actual industry practices and consumer behaviors. Practitioners can contribute to sustainability by 1) designing travel experiences with customer satisfaction maximized through eco-friendly practices, 2) introducing green loyalty programs for encouraging repeat business, 3) promoting user-generated content for positive E-WOM, 4) enhancing destination image emphasizing environmental accountability, and 5) enhancing digital service quality through sustainability-oriented customer engagements.

6 | Conclusion

Research identifies seven critical factors influencing the intention to purchase sustainable tourism destination packages in Thailand via social media. Among these, satisfaction emerged as the most influential determinant, underscoring the need for travel companies to prioritize exceptional customer experiences in their digital marketing efforts. Loyalty and motivation also significantly shape purchase intentions, highlighting the importance of fostering long-term customer relationships and offering compelling incentives. From a theoretical standpoint, integrating RST and the FDM with CFA presents a novel methodological framework for exploring consumer behavior under uncertainty.

This approach contributes to advancing tourism marketing literature by demonstrating the efficacy of hybrid intelligent systems in refining expert input and validating customer intention constructs. Practically, the findings offer actionable insights for tour operators and policymakers aiming to strengthen sustainability-focused marketing strategies. The tourism sector can enhance sustainable consumption behaviors by aligning service delivery with customer expectations and leveraging social media engagement. Future research could expand this framework across other cultural contexts or explore the longitudinal impacts of satisfaction and loyalty on sustained purchase behaviors. Investigating emerging technologies such as AI-driven personalization in tour package promotion can yield further insights into enhancing sustainable tourism uptake.

6.1 | Limitations and Future Directions

While the research offers valuable insights into consumer intentions regarding sustainable tourism packages in Thailand, several limitations can be acknowledged. The data pertains to individuals purchasing domestic

travel packages via social media, which can limit the generalizability of the findings to other populations or offline consumers. Additionally, self-reported data can introduce response biases, comprising socially desirable answers and subjective variability. These limits recommend that findings can be construed within the context of Thai digital consumers and can not fully represent broader or global patterns. Future research could examine factors such as financial status, generational attitudes, or cultural background. It can also be valuable to reproduce this FR hybrid methodology across different industries, such as hospitality, retail, or e-commerce, to assess its adaptability and broaden its theoretical and practical implications. The research findings cannot be universally applicable because respondents purchased tourism packages through social media, which could differ significantly from those who purchased offline or through traditional travel agencies. Future research can include non-digital consumers and international tourist segments to assess the model's applicability in diverse contexts and enhance external validity. This can provide a more comprehensive understanding of sustainable tourism purchase intentions. The findings primarily apply to Thai digital consumers, particularly those using social media to purchase sustainable tourism packages. This limits the generalizability of the results to non-social media users or international tourists. Future research could include these groups to assess the model's applicability in other contexts, enhancing external validity.

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Author Contributaion

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The main article fully documents all original contributions presented in this research. Please contact the corresponding author(s) for additional information or clarification.

Conflicts of Interest

The authors declare no conflict of interest.

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